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PENSOFT

Rediscovery of the extremely rare running crab spider *Philodromus* (*Artanes*) *poecilus* (Thorell, 1872) in Bavaria, Germany, after 141 years (Araneae, Philodromidae)

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Abstract

Philodromus poecilus (Thorell, 1872) is a Transeurasian species reported from most parts of Europe except the British Isles and the Iberian Peninsula. Although widely distributed, this species is extremely rarely recorded in Germany and neighbouring countries. In Bavaria, it has not been found since the time of Ludwig Koch (1825–1908). Recently, several specimens were collected from urban plane trees in Deggendorf (Lower Bavaria), proving that the species is still present in Bavaria. Additionally, images of the copulatory organs and of living and preserved specimens are presented, as is a compilation of records in Germany and neighbouring countries.

Keywords

Biodiversity, cursorial, monitoring, rare species, record scheme, tree trunk

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Introduction

The dionychan spider family Philodromidae (Wheeler et al. 2017), also called running crab spiders, contains over 500 described species of fast-moving, free-hunting spiders that inhabit arboreal as well as epigeic habitats (Jocqué and Dippenaar-Schoeman 2006; World Spider Catalog 2022). In the Western Palearctic, around 120 species from nearly all terrestrial ecosystems are known (Nentwig et al. 2022). The Western-Palearctic members of the family received considerable taxonomic attention in the last decades (e.g., Logunov 1996; Szita and Samu 2000; Muster and Thaler 2004; Muster 2009; Lecigne et al. 2019), and today, most of them can be rapidly determined using online determination keys (Nentwig et al. 2022) or primary literature. However, tree trunks, tree crowns and shrubs—the preferred habitat of many species currently belonging to *Philodromus* Walckenaer, 1826—are still poorly investigated (Blick 2011; Machač and Tuf 2016). As a result, the distribution, life history and the ecology of a majority of species is only little known.

Artanes Thorell, 1869, currently considered a subgenus of *Philodromus*, contains several species that have been frequently misidentified, and many records are in urgent need of verification (Muster 2009). *Philodromus poecilus* (Thorell, 1872) belongs to a clade characterized

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by five or six pairs of ventral spines on tibia I and the presence of spines on some female tarsi (Muster 2009). The known distribution of *P. poecilus* extends from parts of France to Scandinavia and Fennoscandia, Central Asia, and eastwards at least to Khabarovsk, Russia (Marusik et al 2007; Muster 2009; Mikhailov 2013; Nentwig et al. 2022), but this species is very rarely recorded in many areas (Muster 2009). It seems to be absent on the British Isles and the Iberian Peninsula (Nentwig et al. 2022). In Germany, only a very small number of records have been listed in the national recording scheme (Arachnologische Gesellschaft 2022). For Bavaria, the largest federal state of Germany with circa 70 540 km^2, *P. poecilus* is currently red-listed in category 0 ("ausgestorben oder verschollen"; Blick and Scheidler 2004), because it was not recorded since its first report by Koch (1877). In 2018, after 141 years, we were able to collect a considerable number of *P. poecilus* specimens from plane trees (*Platanus* × *hispanica* Mill. ex Münchh. and *Platanus occidentalis* L.) in urban areas in the town of Deggendorf, showing that the species is not only still present in Bavaria, but also in Germany, where it was not recorded since 1980 (Muster 2009). Based on this material, we present images of spiders of both sexes and the copulatory organs. We also provide a detailed depiction of the habitat in Deggendorf, Bavaria. Furthermore, we map all records of this species in Germany and neighboring countries and clarify the status of some records in the literature.

Methods

One of us (HJT) collected all specimens during random surveys of plane trees in the city of Deggendorf, Bavaria (Germany). The spiders were caught by hand in subadult or juvenile stages. Twelve specimens (7 females, 4 males, 1 juvenile) have been deposited in the collection of the State Museum of Natural History Karlsruhe (SMNK-ARA). Habitus images of the preserved specimens were taken with Automontage® software (Syncroscopy, Cambridge, UK) and a Leica DFC 495 digital camera, connected to a Leica Z6 APO microscope (Leica Microsystems, Wetzlar, Germany).

The map (Fig. 1), created with Simplemappr (Shorthouse 2010), contains all records from Germany and neighboring countries (Germany, Switzerland, Austria, regions of Poland bordering Germany, and the Czech Republic; France was excluded) examined in Muster (2009) and the literature mentioned (e.g., Bösenberg 1902) therein. In other parts of the supposed distribution, a large part of historic records are misidentified specimens belonging to other species, e.g. in East Asia (Muster 2009). We also mapped two records from the Netherlands (Van Hasselt 1886) and Belgium (Becker 1882). We used all records examined either by Muster (2009) or with accompanying illustrations/descriptions that allow for clear identification (e.g., Bösenberg 1902; Bryja et al. 2005). The record from Niesky in Muster (2009) is that published by Zimmermann (1871). Additionally, we mapped other historic records without figures or descriptions of the specimens (e.g., Leist 1978; Van Hasselt 1886) but marked them separately in the map. Muster listed the record of Becker (1882) under "?", which is followed here. Two records, from Grenzacher Horn (Lörrach, Germany) and Lützelau near Luzerne in Switzerland are provided by Müller and Schenkel (1895) as "*Ph. ?poccilus* Thor." We considered these records as plausible because of the short but informative description, which mentions five pairs of ventral spines on tibia I and the typical color pattern of *P. poecilus*. All other records from Switzerland (Pavesi 1873; Vogelsanger 1939; Lebert 1877, as *Artanes tigrinus*) are in need of verification (Table 1). More recent records in the literature without figures are categorized as plausible by us because the detailed revision of Muster (2009) was available. The record in Steinberger (2004; Parndorfer Platte) from Austria is very probably a single specimen examined by Muster (2009), as the given locality and collection fits. The material from Vienna examined by Muster (see inventory number, which potentially indicates the year) is possibly, in part, that published by Kulczyński (1898). Although Koch (1877), one of the most accomplished arachnologist of his time, did not illustrate the species and only Thorell's first description was available to him, it is unlikely that he confused the name with another species of the subgenus *Artanes*, especially *P. margaritatus*, which he also mentioned in the same work. Therefore, his records from Bavaria are categorized as reliable.

The nomenclature of the copulatory organs follows Muster (2009).

Results

***Philodromus poecilus* (Thorell, 1872)**
Figures 2–4

For taxonomic references, see World Spider Catalog (2022).

For Bavaria, our material represents the first record of this species after a period of 141 years. In Germany, this species was collected in 1980 for the last time (Muster 2009; Arachnologische Gesellschaft 2022). We interpret our assemblage consisting of several individuals as an established population of the species. The last Bavarian records are described by Koch (1877) and originate from Nuremberg ("Dutzendteich") and the Franconian Jura.

Material examined. GERMANY – **Bavaria** • Deggendorf, Otto-Denk-Straße; wall; 48.8355°N, 012.9510°W; 315 m alt.; 15.XI.2018; H.P. Thorns leg.; T. Bauer det.; 1 ♂, SMNK-ARA 15996 • Deggendorf, Festplatz, under bark of plane tree; 48.832°N, 012.948°E; 312 m alt.; 30.XII.2018–20.II.2019; H.J. Thorns leg.; T. Bauer det.; 6 ♀, 3 ♂, 1 juvenile, SMNK-ARA 18699 • Deggendorf, Fischerdorf, Hauptstraße, under bark of plane tree;

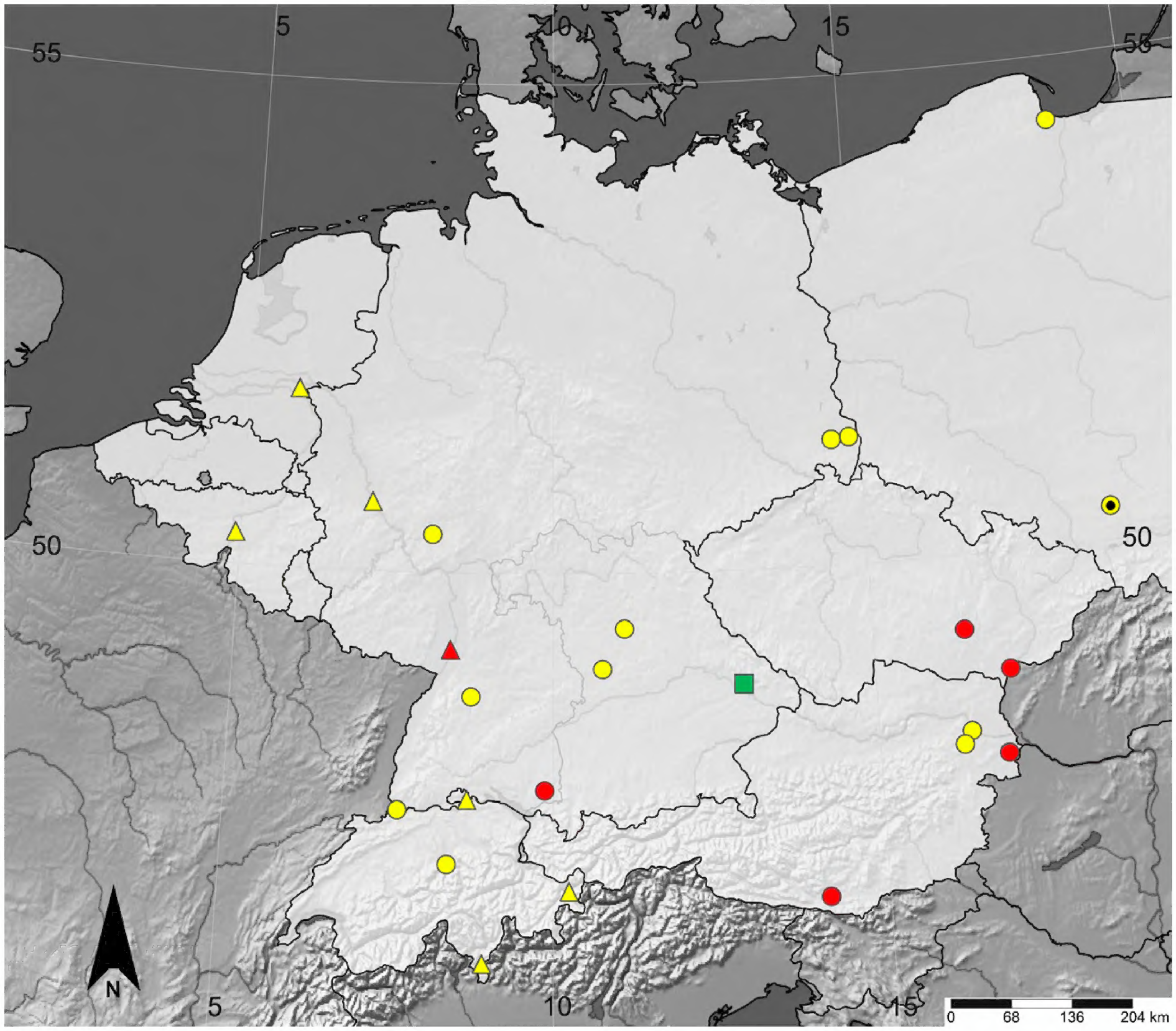

Figure 1. Literature and recent records of *Philodromus poecilus* (Thorell, 1872) in Germany, western Poland, Austria, Switzerland, and the Benelux countries. Triangles = records in need of verification, circles = verified records by Muster (2009), accompanying illustrations or published after 2009. Yellow = historic records before 1950, red = records after 1950. Green Square = rediscovery in Bavaria after 141 years. The record from "Silesia" (Muster 2009) is randomly placed (yellow circle with black core).

48.821°N, 012.953°E; 313 m alt.; 19.II.2019; H.P. Thorns leg.; T. Bauer det.; 1 ♀, SMNK-ARA 18700.

All adult material was collected in subadult stage by hand and raised to adulthood in captivity. The only juvenile specimen died shortly after collecting.

Identification. Adult males of *P. poecilus* can be recognized by the three tibial apophyses (TA), of which the terminal part of the intermediately positioned retrolateral tibial apophysis (RTA; Muster (2009)) appears twisted in retrolateral view (not twisted in *P. fuscomarginatus* (De Geer, 1778)), comparable to a corkscrew. In ventral view, the RTA is more curved and less robust compared to *P. pinetorum* Muster, 2009 (Fig. 4; Muster 2009: fig 14b). We note that the angle in which the three TA are positioned has a strong effect on the visible structures. In retrolateral position, the apical part of the RTA points towards the observer, and due to its twisted structure it can appear as pointed or relatively blunt, depending only on small changes of the position and angle. In Muster (2009), the RTA in retrolateral view appears to be more pointed, while in Almquist (2006), it appears blunt and more similar to Figure 4. In-situ, the oval grooves and the keel (Muster 2009) of the epigyne are not always clearly visible, due to setae covering the epigynal plate (Fig. 4D), and might resemble *P. pinetorum*. In such specimens, the extraction of the epigyne is necessary (Fig. 4E). While the shape of the spermathecae can vary, in dorsal view, the glandular heads are clearly visible and positioned anteriorly, while in *P. pinetorum*, the glandular heads are not visible (Muster 2009).

Habitat. One subadult male was found by chance on 15 November 2018 on a stone wall in the town of Deggendorf, Bavaria, which is situated on the river Donau. In the following weeks until February 2019, HJT actively searched for the species and further 14 specimens were found under loose bark of plane trees (*Platanus ×hispanica* Mill. ex Münchh; Fig. 5) on the Festplatz of

Figure 2. *Philodromus poecilus* (Thorell, 1872). Living specimens. **A.** Female in dorsal view with dipteran prey. **B.** Female in ventral view. **C.** Female in frontal view. **D.** Male in dorsal view.

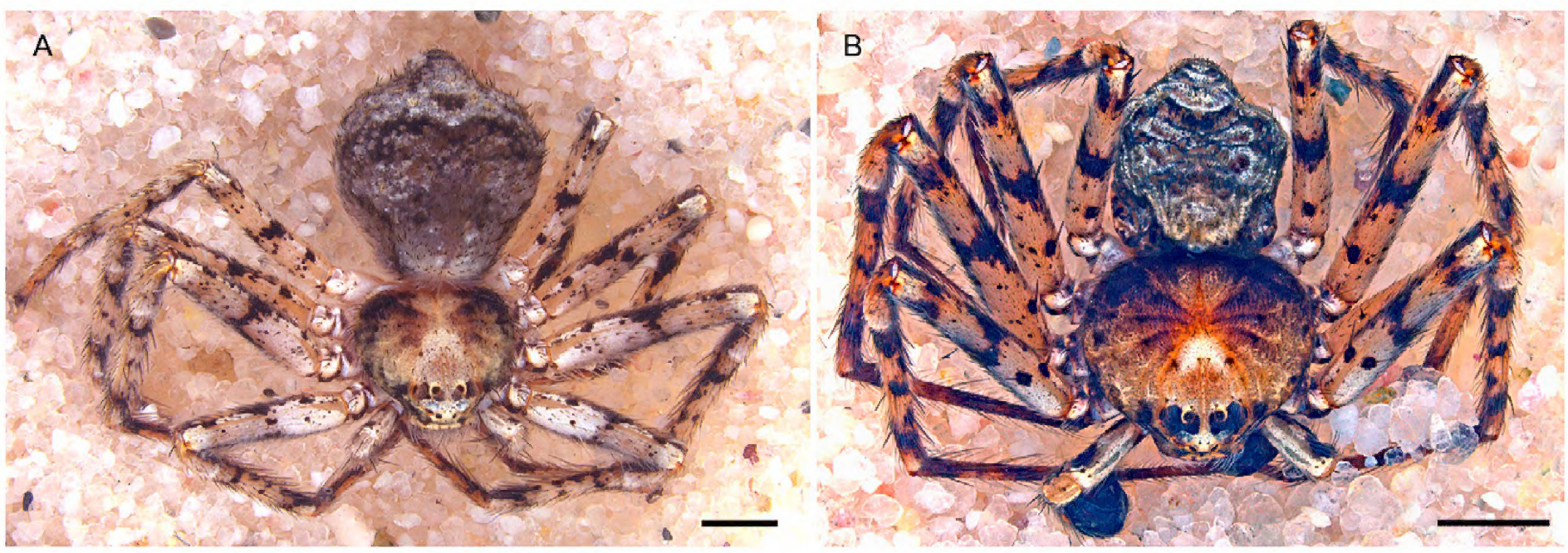

Figure 3. *Philodromus poecilus* (Thorell, 1872). Preserved specimens. **A.** Female in dorsal view. **B.** Male in dorsal view. Scale bars = 1 mm.

Deggendorf (linear distance to first location c. 400 m) and of two plane trees (*Platanus occidentalis* L.) along the Hauptstraße in the city district of Fischerdorf. Latter is located on the opposite waterside of the river Donau. Around 40 plane trees are currently present on the Festplatz, all having a diameter of 20–50 cm. In contrast, the plane trees in Fischerdorf are older, and have a diameter of around 80 cm. While the tree bases of the plane trees on the Festplatz are bordered by small rocks and planted with shrubbery, no shrubs are present under the larger plane trees on Hauptstraße. However, not all plane trees in Deggendorf seem to be colonized by *P. poecilus*, or at least not as densely as the ones from which we collected the species. During the same period, a survey of plane tree alleys along the Edelmairstraße did not result in the collection of any *P. poecilus*, but several (larger) subadult *Philodromus* cf. *margaritatus* were found hiding under bark of these trees. Other spider species found during the surveys were *Nuctenea umbratica* (Clerck, 1757), *Anyphaena accentuata* (Walckenaer, 1802), *Cheiracanthium mildei* L. Koch, 1864, *Micaria subopaca* Westring, 1861, and various juvenile theridiids as well as other philodromids and linyphiids. A high number of the heteropteran *Arocatus longiceps* Stål, 1872 and the alien sycamore lace bug, *Corythucha ciliata* (Say, 1832), were also found under the bark of all trees. During additional surveys in

Figure 4. *Philodromus poecilus* (Thorell, 1872). **A.** Left male palp in ventral view. **B.** Tibialapophysis of male palp, in retrolateral view. **C.** Left palp of male in retrolateral view. **D.** Epigyne in-situ, **E.** Vulva/macerated epigyne dorsal. Scale bars = 0.2 mm.

April, May, and June only two adult specimens of *P. poecilus* were observed on the Festplatz running along the trunk of a tree.

Comments. The compilation of historic records from the literature in Germany, the Benelux countries, Switzerland, western Poland, and Austria revealed 18 localities of the species, in contrast to seven recent localities (including our record), with the latter mostly from Austria and the Czech Republic (Table 1).

Two specimens from "France: 'Galizien'" in the material examined by Muster (2009) and deposited in the Natural History Museum Vienna are probably a lapsus, and the historic area in Eastern Europe (Galicia = Halychyna), today part of Ukraine and Poland, was

Figure 5. Habitat of *Philodromus poecilus* (Thorell, 1872) in Deggendorf, Bavaria. Urban plane trees in January 2019. Specimens of *P. poecilus* were found overwintering in subadult stage under loose bark of the tree trunk.

meant. A vial containing material of *P. poecilus*, labeled only "Galizien" and determined by C. Muster is deposited in the Natural History Museum Vienna (C. Hörweg, pers. comm.) A record of *P. poecilus* from Schleswig-Holstein (Germany) in Irmler and Heydemann (1988) represents a probable misidentification as well (U. Irmler, pers. comm.).

Discussion

Only very little is known about the preferred habitat or microclimatic niche of *Philodromus poecilus*. In his revision, Muster (2009) noted that most species have been collected from the bark of various trees (willows, birches, and poplars, but also pine), and the species seems to prefer wet habitats. The records from Deggendorf are partly in contrast to the reported habitats. Although collected from bark, the habitat is far from being wet or humid. The plane trees on which the species were collected are located in urbanized areas with extensive soil sealing. However, Deggendorf is located directly on the river Donau, like Vienna, from which other records of the species are known (Muster 2009) and is probably affected from evaporation of water during hot summer days and cooling in the night. The city also experiences relatively high average precipitation per year in comparison (DWD 2021). The last record in Germany was made near Kißlegg (Baden-Württemberg), another region with high precipitation (DWD 2021; Muster 2009). A recent record in Austria was made near Wörthersee (Komposch 2011). In Abkhazia, the species was recorded near lake Ritsa (Kovblyuk et al. 2011), in the Ust-Belsk natural park (Russia) at the bank of a dried-out river (Sozontov and Esyunin 2014). However, a recent record from Bulgaria was taken from a dry slope far away from any water (Dimitrov and Naumova 2021). Interestingly, Pavesi (1873) described the species as not rare under the bark of plane trees of a certain park in Lugano ("non raro, specialmente sotto la corteccia dei platani nel parco Ciani in Lugano"), which is situated on the bank of Lake Lugano. This fits perfectly to our observations.

Table 1. Records of *Philodromus poecilus* (Thorell, 1872) in Germany, Austria, Czech Republic, Switzerland, parts of western Poland, and the Benelux countries. Literature: historical records before 1950 in bold. Status: VE = verified by Muster (2009), accompanying drawings/descriptions or published after 2009, ? = in need of verification.

Country	City/location	Geographic coordinates	Literature	Status
Austria	Vienna	48.208, 016.406	**Muster 2009**	VE
Austria	Mödling	48.078, 016.281	**Muster 2009**	VE
Austria	Parndorfer Platte	47.955, 016.940	Muster 2009	VE
Austria	Wörthersee	46.627, 014.114	Komposch 2011	VE
Belgium	Yvoir	50.323, 004.924	**Becker 1882**	?
Czech Rep.	Hvozdec	49.246, 016.425	Kůrka 1997	VE
Czech Rep.	Mikulèice	48.807, 017.082	Bryja et al. 2005	VE
Germany	Limburg	50.386, 008.074	**Muster 2009**	VE
Germany	Hirsau	48.734, 008.729	**Bösenberg 1902**	VE
Germany	Niesky	51.302, 014.820	**Muster 2009**	VE
Germany	Hörnli, Grenzach	47.565, 007.641	**Müller and Schenkel 1895**	VE
Germany	Nuremberg	49.429, 011.115	**Koch 1877**	VE
Germany	Bonn	50.704, 007.098	**Bertkau 1880**	?
Germany	Franconian Jura	49.018, 010.767	**Koch 1877**	VE
Germany	Kissleg	47.782, 009.869	Muster 2009	VE
Germany	Rußheimer Altrhein	49.212, 008.396	Leist 1978	?
Germany	"Lausitz"	51.284, 014.532	**Muster 2009**	VE
Netherlands	Nijmegen	51.828, 005.822	**Van Hasselt 1886**	?
Poland	Danzig	54.343, 018.633	**Menge 1875**	VE
Poland	"Silesia"	50.347, 018.924	**Muster 2009**	VE
Switzerland	Unterengadin	46.752, 010.234	**Lebert 1877**	?
Switzerland	Schlatt, Schaaren	47.682, 008.689	**Vogelsanger 1939**	?
Switzerland	Lugano	46.012, 008.950	**Pavesi 1873**	?
Switzerland	Luzern, Lützelau	47.077, 008.560	**Müller and Schenkel 1895**	VE

The location and our findings of *P. poecilus* demonstrate that urban habitats are clearly undersampled, may harbour several spider species of conservation concern (e.g., Van Keer 2010; Möller et al. 2019; Indzhov 2021) and should always be integrated in in future biodiversity surveys (Li et al. 2019). In Bavaria, tree trunks and tree crowns in urban habitats should be particularly targeted, as those habitats were heavily neglected in the past (Blick and Scheidler 2004). There seems to be a small chance that *P. poecilus* is not as rare in Bavaria as suggested by the currently known situation and more widespread in some synanthropic habitats. However, the German spider recording scheme (Arachnologische Gesellschaft 2022) now contains an increasing number of records from private gardens and other synanthropic habitats made by citizen scientists and identified by specialists (e.g., data provided by two of us—HJT and JG). So far, only one of us (HJT) has been successful in collecting this species. It seems more likely that *P. poecilus* is very rare in Bavaria and restricted to only a few locations.

Muster (2009) noted a comparatively large number of specimens in historic collections and their nearly complete absence in recent assemblages. He suggested, based on this observation, that *P. poecilus* (and other related species) declined substantially in the last decades due to unknown reasons. For Germany and neighboring countries, this hypothesis is supported by the presence (respectively absence) of records in the historic and recent faunistic and taxonomic literature as well as modern record schemes (Table 1). In recent times since the work of Muster, Blick (2009, 2011, 2012) carried out large and very thorough investigations of German forest reserves targeting various strata with various sampling strategies, but obtained no specimens of *P. poecilus*. Given the great number of specimens and species caught (e.g., Blick 2009), it is surprising that *P. poecilus* is absent in these assemblages but present in the historic collections, which usually contain specimens mostly collected by hand. Most of this research was conducted in regions from where historical authors describe records or from which specimens are deposited in museum collections (see e.g., Muster 2009). In Germany, *P. poecilus* was last collected in 1980 in Kißlegg, Baden-Württemberg (Muster 2009). Bösenberg (1902) mentioned that he collected the species in the Black Forest (Baden-Württemberg) and several of his fellow arachnologists sampled it in other regions of Germany. During various projects, the arachnologists (including one of us, TB) from the State Museum of Natural History Karlsruhe were not able to find the species in Black Forest National Park (but *Philodromus laricium* Simon, 1875, another very rare philodromid; see Höfer et al. 2019). Menge (1875, as *Artanes margaritatus*; see Muster 2009) described it as not rare in his region (Gdańsk (Danzig) and vicinity). In Switzerland, the current distribution of *P. poecilus* is completely unknown. There seem to be no recent records and the species is absent in the Swiss recording scheme (CSCF 2021). Several bibliographical records of historic authors (Pavesi 1873; Lebert 1877; Vogelsanger 1939) need confirmation, as no material is illustrated. However, the situation seems to be different in Eastern Europe and Russia. Several recent records of *P. poecilus* (e.g., Kovblyuk et al. 2011; Sozontov and Esyunin 2012, 2014; Ponomarev et al. 2019; Polchaninova 2020; Dimitrov and Naumova 2021) suggest that the species is widespread there and still fairly common. Interestingly, all of the mentioned records are based on the morphological identification of females only. Further investigations, including genetic analyses of material from this regions seems necessary to reassure this assessment.

Philodromus poecilus and the larger *P. margaritatus* (Clerck, 1757), like many representatives of the subgenus *Artanes*, share a similar microhabitat (bark of trees) and possess a similar cryptic color pattern. The latter species is frequently reported to the German spider recording scheme (Atlas der Spinnentiere Europas 2022). As a result, undersampling due to the microhabitat seems therefore very unlikely. Other record schemes in Central Europe contain comparable record numbers. In the Czech Republic, only two records are present (Czech Arachnological Society 2021), similar to the record scheme of the Benelux with one locality (Tutelaers 2021). France is the only country with a larger number of records in the record scheme (>10) (Muséum national d'Histoire naturelle 2021). Muster (2009) pointed out that the species has been frequently confused with *P. pinetorum* in France and is probably not present in the Simon collection. However, Oger (2021) presented a female specimen from Lussat on his website, giving evidence that the species is still present in France. It would be interesting to examine further material from France, especially from the south of the country, from which most records of *P. poecilus* and *P. pinetorum* in the French record scheme originate. Based on the remarks and specimens examined by Muster (2009), it seems possible that some of the French *P. poecilus* records are misidentified. The situation in Poland is very complicated. Several historic records, especially from the southeast, are in need of verification and apparently no recent record of the species is known (BioMap Poland 2022; Prószyński and Staręga 1971). Records from eastern Central Europe, Southern Europe and Eastern Europe (e.g., Szinetár 1992; Bosmans and Chatzaki 2005) prior to the revision of Muster (2009) should also be verified, if material is still available. Muster described *Philodromus pinetorum* and *P. pentheri* Muster, 2009 from the Mediterranean Region and the Balkans. Both represent taxa that were potentially mistaken for *P. poecilus* in the past, in addition to the frequent misidentification with other species.

Philodromus poecilus is a very rare spider species in Germany and neighboring countries, and its populations are probably declining for unknown reasons (Muster 2009; Fig. 1). Therefore, the described urban population of *P. poecilus* in Deggendorf, Bavaria, is of very high regional importance for the conservation of this species. If future efforts to locate further populations of *P.*

poecilus in synanthropic habitats fail, we propose *P. poecilus* should be promoted to category I in the next Red List of Germany because the current assessment (category II; Blick et al. 2016) does not reflect the historic and recent evidence of a substantial population decline and the extreme rarity of the species. In addition, known habitats of the species should be protected by law. In this case, as the species occupies an urban habitat, all plane trees in Deggendorf should be excluded from unnecessary felling, with the only exception being security issues (e.g., dangerous, storm-damage trees). If possible, additional plane trees should be planted in Deggendorf to provide more habitat for *P. poecilus*.

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Authors' Contributions

Conceptualization: HJT, TB, JG. Data curation: TB. Visualization: HJT, TB, JG. Writing – original draft: TB. Writing – review and editing: JG, HJT.

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